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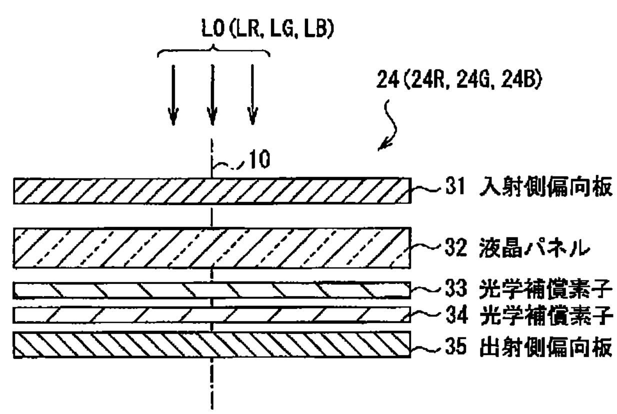
(54)【発明の名称】 投射型液晶表示装置

(57)【要約】

【課題】 黒レベルの表示を改善し、従来に比べてコントラストの高い画像表示を行うことができる投射型液晶表示装置を提供する。

【解決手段】 液晶パネル３２に対して光の出射側に光学補償素子３４を設け、液晶層における光の入射側領域に存在する液晶分子に対する光学補償を行う。光学補償素子３４を液晶パネル３２に対して光の出射側に設けているので、液晶パネル３２に設けられているマイクロレンズ４２の影響を受けることなく、光の入射側領域に存在する液晶分子によって生じる複屈折を解消することができる。これにより、マイクロレンズ４２の影響を受けることなく、黒レベルの表示を改善し、従来に比べてコントラストの高い画像表示を行う。



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【特許請求の範囲】

【請求項１】　画像表示に必要とされる光を発する光源と、
複数の液晶分子がねじれた状態で配列された液晶層を有し、前記液晶層に画像信号に応じて選択的に電圧を印加することにより、前記液晶分子の配列状態を変化させ、前記液晶層を透過する光を変調させる透過型の液晶表示素子と、
前記液晶表示素子に対して光の出射側に設けられ、前記液晶層の光の入射側領域における液晶分子によって生じる光学的な位相差を補償する第１の光学補償素子と、
前記液晶表示素子によって変調された光を投射する投射レンズとを備えたことを特徴とする投射型液晶表示装置。

【請求項２】　前記第１の光学補償素子は、負結晶が持つ複屈折性に相当する複屈折性を有する物質を含んで構成されていることを特徴とする請求項１記載の投射型液晶表示装置。

【請求項３】　前記液晶層において、各液晶分子は、電圧を印加した状態で、光の入射側領域および出射側領域から中心部に向かうに従い、その分子長軸が、光の入射面に対して平行もしくはそれに近い状態から、光の入射面に対して垂直もしくはそれに近い状態となるように配列状態が変化するものであり、
前記第１の光学補償素子は、電圧を印加した状態における液晶分子の配列状態に対応して、前記複屈折性を有する物質を構成する複数の分子が、光の入射側から出射側に向かうに従い、その光学軸が、光の入射面に対して垂直もしくはそれに近い状態から、光の入射面に対して平行もしくはそれに近い状態へと変化するように配列されていることを特徴とする請求項２記載の投射型液晶表示装置。

【請求項４】　さらに、前記液晶表示素子に対して光の出射側に設けられ、負結晶が持つ複屈折性に相当する複屈折性を有する物質を含み、前記液晶層の光の出射側領域における液晶分子によって生じる光学的な位相差を補償する第２の光学補償素子を備えたことを特徴とする請求項１記載の投射型液晶表示装置。

【請求項５】　前記液晶層において、各液晶分子は、電圧を印加した状態で、光の入射側領域および出射側領域から中心部に向かうに従い、その分子長軸が、光の入射面に対して平行もしくはそれに近い状態から、光の入射面に対して垂直もしくはそれに近い状態となるように配列状態が変化するものであり、
前記第２の光学補償素子は、電圧を印加した状態における液晶分子の配列状態に対応して、前記複屈折性を有する物質を構成する複数の分子が、光の出射側から入射側に向かうに従い、その光学軸が、光の入射面に対して垂直もしくはそれに近い状態から、光の入射面に対して平行もしくはそれに近い状態へと変化するように配列されていることを特徴とする請求項４記載の投射型液晶表示装置。

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【請求項６】　前記液晶層の光の入射側には、入射した光を前記液晶層側に集光させる複数のマイクロレンズが設けられていることを特徴とする請求項１記載の投射型液晶表示装置。

【請求項７】　さらに、前記液晶表示素子に対して光の入射側と出射側とに配置された、互いに直交ニコルの関係にある一対の偏光子を備え、
前記第１の光学補償素子は、光の出射側に配置された偏光子と前記液晶表示素子との間に設けられていることを特徴とする請求項１記載の投射型液晶表示装置。

【請求項８】　さらに、前記液晶表示素子に対して光の出射側に設けられ、前記液晶層のうち、光の入射側領域と出射側領域とを除いた領域に存在する液晶分子によって生じる光学的な位相差を補償する第３の光学補償素子を備えたことを特徴とする請求項１記載の投射型液晶表示装置。

【請求項９】　前記第３の光学補償素子は、負の１軸性結晶が持つ複屈折性に相当する複屈折性を有する物質を含んで構成されていることを特徴とする請求項８記載の投射型液晶表示装置。

【請求項１０】　前記液晶層内の各液晶分子は、正の１軸性結晶が持つ複屈折性に相当する複屈折性を有し、前記液晶層において、電圧を印加した状態で、光の入射側領域および出射側領域から中心部に向かうに従い、その分子長軸が、光の入射面に対して平行もしくはそれに近い状態から、光の入射面に対して垂直もしくはそれに近い状態となるように配列状態が変化するものであり、
前記第３の光学補償素子は、光の入射面に対して分子長軸が垂直に配列された液晶分子に対して、その分子長軸に斜めから光が入射することによって生じる光学的な位相差を補償する機能を有し、
前記第３の光学補償素子を構成する複屈折性を有する物質は、その光学軸が、前記液晶層に電圧を印加した状態で、補償対象となる液晶分子の分子長軸と平行になるように配列されていることを特徴とする請求項９記載の投射型液晶表示装置。

【請求項１１】　前記液晶層の光の入射側には、入射した光を前記液晶層側に集光させる複数のマイクロレンズが設けられていることを特徴とする請求項８記載の投射型液晶表示装置。

【請求項１２】　さらに、前記液晶表示素子に対して光の入射側と出射側とに配置された、互いに直交ニコルの関係にある一対の偏光子を備え、
前記第１の光学補償素子および第２の光学補償素子は、光の出射側に配置された偏光子と前記液晶表示素子との間に設けられていることを特徴とする請求項８記載の投射型液晶表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、液晶表示素子を用いて画像を表示するようにした投射型液晶表示装置に関する。

【０００２】

【従来の技術】従来より、液晶表示素子（以下、液晶パネルという。）によって光変調された光をスクリーンに投射して、画像を表示するようにした投射型液晶表示装置（液晶プロジェクタ）がある。投射型液晶表示装置における画像の投射方式としては、スクリーンの前面側より画像を投射する前面投射式（フロント式）と、スクリーンの背面側より画像を投射する背面投射式（リア式）とがある。また、投射型液晶表示装置において、カラー表示を行うものには、液晶パネルを１枚用いる単板方式と、赤（Red＝R），緑（Green＝G），青（Blue＝B）の３つの色光に対応した３枚の液晶パネルを用いる３板方式とがある。

【０００３】投射型液晶表示装置においては、ＴＮ（Twisted Nematic；ねじれネマチック）型の液晶パネルが多く使用されている。ＴＮ型の液晶パネルは、ネマチック液晶を、２つの基板間にねじれた状態で封入したものである。ネマチック液晶は、複数の棒状の分子からなるものであり、その分子長軸が一定の方向に揃った状態で配列されている。また、ネマチック液晶は、一般に、正の１軸性結晶が持つ複屈折性に相当する複屈折性を有している。この場合、液晶分子の光学軸の方向は、分子長軸の方向と同一となる。ＴＮ型の液晶パネルでは、分子長軸が、２つの基板のそれぞれに対して平行となるように配列すると共に、一方の基板から他方の基板に向かうに従い、分子長軸が９０°ねじれた状態となるようにして、ネマチック液晶を封入している。このようなＴＮ型の液晶パネルに、電圧を印加しない通常状態で光が入射すると、液晶のねじれによって旋光性が生じ、光の振動方向が液晶のねじれに沿って９０°回転させられる。一方、ＴＮ型の液晶パネルに電圧を印加すると、分子長軸が基板に対して垂直となるように液晶分子の配列状態が変化し、旋光性が失われる。従って、この状態で入射した光は、振動方向が一定の状態で液晶パネルを透過する。

【０００４】図１３は、投射型液晶表示装置における液晶パネル周辺部の構成例を表している。この構成例では、液晶パネル１０１に対して、光の入射側に入射側偏光板１０２が配置され、光の出射側に出射側偏光板１０３が配置されている。液晶パネル１０１は、ＴＮ液晶を用いた透過型のものであり、内部の図示しない２つの基板間に、ネマチック液晶をねじれた状態で封入している。入射側偏光板１０２と出射側偏光板１０３は、光の透過軸が互いに直交した、いわゆる直交ニコルの関係となるように配置されている。入射側偏光板１０２の透過軸は、液晶パネル１０１の入射側の基板表面における液晶分子の配列方向と同一方向となるように設定されている。一方、出射側偏光板１０３の透過軸は、液晶パネル１０１の出射側の基板表面における液晶分子の配列方向と同一方向となるように設定されている。

【０００５】このような構成において、入射側偏光板１０２に図示しない光源からの照射光Ｌ０が入射すると、入射側偏光板１０２の透過軸と同一の振動方向の直線偏光成分１１１のみが、入射側偏光板１０２を透過する。一方、入射側偏光板１０２の透過軸に直交する振動方向の光成分１１２は、入射側偏光板１０２に吸収され透過しない。入射側偏光板１０２を透過した光成分１１１は、次に、液晶パネル１０１に入射する。

【０００６】ここで、液晶パネル１０１において液晶層に電圧を印加していない通常状態であるときには、液晶のねじれによって旋光性が生じ、光の振動方向が液晶のねじれに沿って９０°回転させられる。これにより、液晶パネル１０１を出射した光は、その振動方向が出射側偏光板１０３の透過軸と同一方向になり、出射側偏光板１０３を透過する。出射側偏光板１０３を透過した光は、図示しない投射光学系を介してスクリーンに投射される。このとき、画像の表示状態は、いわゆる白レベルの表示となる。一方、液晶パネル１０１において液晶層に電圧を印加している通電状態のときには、その分子長軸が光軸１００と同一方向となるように液晶分子の配列状態が変化して、旋光性が失われる。従って、入射側偏光板１０２を透過した直線偏光成分１１１が、図１３に示したように、その振動方向を保った状態で、液晶パネル１０１を出射する。この振動方向を保った状態で出射した光は、出射側偏光板１０３に吸収され、透過しない。このとき、画像の表示状態は、いわゆる黒レベルの表示となる。このように、液晶パネルにおいて、液晶層に電圧を印加しない通常状態で光を透過させて白レベルの表示を行う表示方式は、一般に「ノーマリ・ホワイト」と呼ばれている。

【０００７】

【発明が解決しようとする課題】ところで、図１３に示した構成例において、理想的な黒レベルの表示を行うためには、通電状態のときに、液晶パネル１０１から、振動方向が出射側偏光板１０３の透過軸と直交する直線偏光成分１１１のみを出射する必要がある。しかしながら、実際には、液晶パネル１０１の特性により、通電状態のときに、直線偏光成分１１１に直交する振動方向の光成分１１３が発生する（図２参照）。ここで発生した光成分１１３は、その振動方向が出射側偏光板１０３の透過軸と同方向であるため、出射側偏光板１０３をそのまま透過する。この光成分１１３の光強度は、入射側偏光板１０２によって吸収された同一振動方向の光成分１１２に比べると小さいものではあるが、黒レベルの表示を十分劣化させる虞がある。このような黒レベル表示の劣化は、画像表示におけるコントラストの低下を招くの

で問題となる。なお、図１４では、直線偏光成分１１１に直交する光成分１１２、１１３の光強度の大小関係を、円形状の図形の大きさによって模式的に表している。

【０００８】ここで、通電状態のときにも、液晶パネル１０１から不要な光成分が出射される理由について簡単に説明する。なお以下では、液晶分子が正の１軸性結晶と同様の複屈折性を有しているものとして説明する。通電状態のときに、液晶分子の分子長軸が、液晶層の全ての領域において光軸１００と同一方向となるように配列されていれば、光軸１００に平行に入射する光については、その振動方向を保った状態で、液晶パネル１０１を出射させることができる。しかしながら、一般には、通電状態において、全ての領域における液晶分子が、光軸１００と同一方向となるように配列されることは少ない。特に、液晶層の界面付近に存在する液晶分子は、通電状態においても、配列状態が十分変化せず、その分子長軸が光軸１００に対して傾斜した状態となっている。従って、液晶層に入射した光は、界面付近に存在する液晶分子、すなわち、液晶層における光の入射側領域と出射側領域とにある液晶分子によって、光の振動方向が変化させられる。このようにして、液晶パネル１０１において不要な光成分が発生すると、液晶パネル１０１に入射した直線偏光の光が楕円偏光となって出射されることになる。

【０００９】一方、いわゆる直視型の液晶表示装置の分野では、従来より、液晶分子の複屈折性のために、液晶パネルを斜めから見た状態のときに、光の透過状態が変化し、画像の表示品位が低下する問題があることが知られている。この問題は、一般に、視野角依存性と呼ばれている。直視型の液晶表示装置の分野においては、近年、この視野角依存性を改善するための光学補償素子が開発されている。そこで、このような直視型の液晶表示装置向けに開発されている光学補償素子を、投射型液晶表示装置に使用することで、コントラストの改善を行うことが考えられる。

【００１０】図１５は、上述の光学補償素子を、投射型液晶表示装置に適用した場合の構成例を示している。図１５に示した構成例は、光学補償素子１０４，１０５を備えていること以外は、実質的に図１３に示した構成と同様である。図１５に示したように、光学補償素子１０４は、入射側偏光板１０２と液晶パネル１０１との間に配置されている。光学補償素子１０５は、液晶パネル１０１と出射側偏光板１０３との間に配置されている。光学補償素子１０４は、液晶層における光の入射側領域の液晶分子によって生ずる光学的な位相差を補償する機能を有している。一方、光学補償素子１０５は、液晶層における光の出射側領域の液晶分子によって生ずる光学的な位相差を補償する機能を有している。

【００１１】このような構成において、入射側偏光板１０２から出射した直線偏光成分１１１が、光学補償素子１０４に入射すると、光学補償素子１０４の作用により、図示したように、直線偏光成分１１１に直交する振動方向の光成分１１４が発生する。光学補償素子１０４から出射した光成分１１４と直線偏光成分１１１は、次に、液晶パネル１０１に入射する。液晶パネル１０１が通電状態であるときには、入射した光が、まず、液晶層の光の入射側領域に存在する液晶分子の複屈折性によって、直線偏光成分１１１のみに変換される。このようにして、光学補償素子１０４は、結果的に、液晶層における光の入射側領域の液晶分子によって生ずる光学的な位相差を補償する。

【００１２】直線偏光成分１１１の光が、さらに、液晶層の光の出射側領域を透過すると、出射側領域に存在する液晶分子の複屈折性によって、直線偏光成分１１１に直交する振動方向の光成分１１５が、再び発生する。液晶パネル１０１から出射された光成分１１５と直線偏光成分１１１の光は、光学補償素子１０５の作用により、図示したように、直線偏光成分１１１のみとなって出射される。このようにして、光学補償素子１０５は、液晶層における光の出射側領域の液晶分子によって生ずる光学的な位相差を補償する。これにより、光学補償素子１０５から出射されるのは、出射側偏光板１０３の透過軸に直交する直線偏光成分１１１のみとなり、出射側偏光板１０３によって吸収される。以上のようにして、光学補償素子１０４，１０５によって、黒レベル表示の劣化が防止され、コントラスト改善を行うことができる。

【００１３】一般に、光学補償素子を利用する場合には、光学補償素子に入射する光の入射角度が、補償しようとする液晶領域に入射する光の入射角度と同一となるように設定されていると、理想的な光学補償を行うことができる。しかしながら、投射型液晶表示装置に使用される液晶パネルには、光の入射側領域に、開口効率の向上や色純度の向上のために、マイクロレンズが配置されることが多い。このように、光学補償素子と液晶パネルとの間に他の光学要素が配置されると、光学補償素子に対する光の入射角度と、液晶領域に入射する光の入射角度とに差が生じる。このような状態になると、光学補償素子によって、十分な光学補償を行うことができなくなり、コントラストの低下を招くという問題が生ずる。

【００１４】本発明はかかる問題点に鑑みてなされたもので、その目的は、黒レベルの表示を改善し、従来に比べてコントラストの高い画像表示を行うことができる投射型液晶表示装置を提供することにある。

【００１５】

【課題を解決するための手段】本発明による投射型液晶表示装置は、画像表示に必要とされる光を発する光源と、複数の液晶分子がねじれた状態で配列された液晶層を有し、液晶層に画像信号に応じて選択的に電圧を印加することにより、液晶分子の配列状態を変化させ、液晶

層を透過する光を変調させる透過型の液晶表示素子と、液晶表示素子に対して光の出射側に設けられ、液晶層の光の入射側領域における液晶分子によって生じる光学的な位相差を補償する第１の光学補償素子と、液晶表示素子によって変調された光を投射する投射レンズとを備えている。

【００１６】なお、本発明による投射型液晶表示装置において、第１の光学補償素子は、負結晶が持つ複屈折性に相当する複屈折性を有する物質を含んで構成されていることが望ましい。また、本発明による投射型液晶表示装置は、液晶表示素子に対して光の出射側に設けられ、液晶層の光の出射側領域における液晶分子によって生じる光学的な位相差を補償する第２の光学補償素子を、さらに備えることが望ましい。

【００１７】また、本発明による投射型液晶表示装置は、液晶表示素子に対して光の出射側に設けられ、液晶層のうち、光の入射側領域と出射側領域とを除いた領域に存在する液晶分子によって生じる光学的な位相差を補償する第３の光学補償素子を、さらに備えることが望ましい。第３の光学補償素子は、例えば、負の１軸性結晶が持つ複屈折性に相当する複屈折性を有する物質によって構成されていることが望ましい。第３の光学補償素子は、例えば、液晶層内の各液晶分子が、正の１軸性結晶が持つ複屈折性に相当する複屈折性を有し、電圧を印加した状態で、光の入射側領域から中心部に向かうに従い、その分子長軸が、光の入射面に対して平行もしくはそれに近い状態から、光の入射面に対して垂直もしくはそれに近い状態となるように配列状態が変化するように配列されている場合に、その分子長軸が光の入射面に対して垂直に配列された液晶分子によって生じる光学的な位相差を補償するものである。このとき、第３の光学補償素子を構成する複屈折性を有する物質は、その光学軸が、液晶層に電圧を印加した状態で、補償対象となる液晶分子の分子長軸と平行になるように配列されていることが望ましい。

【００１８】本発明による投射型液晶表示装置では、液晶表示素子に対して光の出射側に設けられた第１の光学補償素子によって、液晶層の光の入射側領域における液晶分子によって生じる光学的な位相差が補償される。

【００１９】また、本発明による投射型液晶表示装置では、例えば負の１軸性結晶が持つ複屈折性に相当する複屈折性を有する物質によって構成された第３の光学補償素子によって、例えば、液晶層内の各液晶分子が、正の１軸性結晶が持つ複屈折性に相当する複屈折性を有し、電圧を印加した状態で、光の入射側領域から中心部に向かうに従い、分子長軸が光の入射面に対して垂直となるように配列されている場合に、その分子長軸が垂直に配列された液晶分子によって生じる光学的な位相差が補償される。

【００２０】

【発明の実施の形態】以下、本発明の実施の形態について図面を参照して詳細に説明する。

【００２１】［第１の実施の形態］図１は、本発明の第１の実施の形態に係る投射型液晶表示装置の全体構成を示している。この図に示した投射型液晶表示装置は、透過型の液晶パネルを３枚用いてカラー画像表示を行う３板方式のものである。この投射型液晶表示装置は、光軸１０に沿って、光源１１と、ＵＶ（紫外線）／ＩＲ（赤外線）カットフィルタ１２と、フライアイレンズ１３，１４と、集光レンズ１５と、ダイクロイックミラー１６とを順番に備えている。

【００２２】光源１１は、カラー画像表示に必要とされる、赤色光、青色光および緑色光を含んだ白色光を発するようになっている。この光源１１は、白色光を発する発光体１１ａと、発光体１１ａから発せられた光を反射、集光する凹面鏡１１ｂとを含んで構成されている。発光体１１ａとしては、例えば、ハロゲンランプ、メタルハライドランプまたはキセノンランプ等が使用される。凹面鏡１１ｂは、集光効率が良い形状であることが望ましく、例えば回転楕円面鏡や回転放物面鏡等の回転対称な面形状となっている。

【００２３】ＵＶ／ＩＲカットフィルタ１２は、光源１１から発せられた白色光に含まれる紫外および赤外領域の光を除去する機能を有している。フライアイレンズ１３，１４は、ＵＶ／ＩＲカットフィルタ１２を透過した光を拡散させて光の照度分布を均一化する機能を有している。ダイクロイックミラー１６は、ＵＶ／ＩＲカットフィルタ１２、フライアイレンズ１３，１４および集光レンズ１５を介して入射した光を、赤色光ＬＲと、その他の色光とに分離する機能を有している。

【００２４】この投射型液晶表示装置は、また、ダイクロイックミラー１６によって分離された赤色光ＬＲの光路に沿って、全反射ミラー１７と、集光レンズ２３Ｒと、液晶パネル部２４Ｒとを順番に備えている。全反射ミラー１７は、ダイクロイックミラー１６によって分離された赤色光ＬＲを、液晶パネル部２４Ｒに向けて反射するようになっている。集光レンズ２３Ｒは、ダイクロイックミラー１６によって反射された赤色光ＬＲを、液晶パネル部２４Ｒに集光するようになっている。液晶パネル部２４Ｒは、全反射ミラー１７および集光レンズ２３Ｒを介して入射した赤色光ＬＲを、画像信号に応じて空間的に変調する機能を有している。

【００２５】この投射型液晶表示装置は、さらに、ダイクロイックミラー１６によって分離された他の色光の光路に沿って、ダイクロイックミラー１８を備えている。ダイクロイックミラー１８は、入射した光を、緑色光と青色光とに分離する機能を有している。

【００２６】この投射型液晶表示装置は、また、ダイクロイックミラー１８によって分離された緑色光ＬＧの光路に沿って、集光レンズ２３Ｇと、液晶パネル部２４Ｇ

とを順番に備えている。集光レンズ２３Ｇは、ダイクロイックミラー１８によって分離された緑色光ＬＧを、液晶パネル部２４Ｇに集光するようになっている。液晶パネル部２４Ｇは、集光レンズ２３Ｇを介して入射した緑色光ＬＧを、画像信号に応じて空間的に変調する機能を有している。

【００２７】この投射型液晶表示装置は、さらに、ダイクロイックミラー１８によって分離された青色光ＬＢの光路に沿って、リレーレンズ１９と、全反射ミラー２０と、リレーレンズ２１と、全反射ミラー２２と、集光レンズ２３Ｂと、液晶パネル部２４Ｂとを順番に備えている。全反射ミラー２０は、ダイクロイックミラー１８によって分離され、リレーレンズ１９を介して入射した青色光ＬＢを、全反射ミラー２２に向けて反射するようになっている。全反射ミラー２２は、全反射ミラー２０によって反射され、リレーレンズ２１を介して入射した青色光ＬＢを、液晶パネル部２４Ｂに向けて反射するようになっている。液晶パネル部２４Ｂは、全反射ミラー２２によって反射され、集光レンズ２３Ｂを介して入射した青色光ＬＢを、画像信号に応じて空間的に変調する機能を有している。

【００２８】この投射型液晶表示装置は、また、赤色光ＬＲ、緑色光ＬＧおよび青色光ＬＢの光路が交わる位置に、3つの色光ＬＲ、ＬＧ，ＬＢを合成する機能を有したダイクロイックプリズム２５を備えている。この投射型液晶表示装置は、また、ダイクロイックプリズム２５から出射された合成光を、スクリーン２７に向けて投射するための投射レンズ２６を備えている。ダイクロイックプリズム２５は、3つの入射面２５Ｒ，２５Ｇ，２５Ｇと、１つの出射面２５Ｔとを有している。入射面２５Ｒには、液晶パネル部２４Ｒから出射された赤色光ＬＲが入射するようになっている。入射面２５Ｇには、液晶パネル部２４Ｇから出射された緑色光ＬＧが入射するようになっている。入射面２５Ｂには、液晶パネル部２４Ｂから出射された青色光ＬＢが入射するようになっている。ダイクロイックプリズム２５は、入射面２５Ｒ，２５Ｇ，２５Ｇに入射した3つの色光を合成して出射面２５Ｔから出射する。

【００２９】図2は、液晶パネル部の要部構成を表すものである。液晶パネル部２４Ｒ，２４Ｇ，２４Ｂは、変調対象となる光の成分が異なるのみで、その機能、構成は実質的に同じである。以下では、各色用のパネル部の構成をまとめて説明する。図２に示したように、液晶パネル部２４（２４Ｒ，２４Ｇ，２４Ｂ）は、光の入射側から順に、入射側偏光板３１と、液晶パネル３２と、光学補償素子３３，３４と、出射側偏光板３５とを有している。液晶パネル部２４の各光学要素における光の入射面および出射面は、光軸１０と直交している。液晶パネル３２は、ＴＮ液晶を用いた透過型のものであり、その内部には、ネマチック液晶がねじれた状態で封入されている。入射側偏光板３１と出射側偏光板３５は、入射した光のうち、所定の振動方向の直線偏光光のみを透過するようになっている。光学補償素子３３は、液晶パネル３２内の液晶層における光の出射側領域の液晶分子によって生ずる光学的な位相差を補償する機能を有している。一方、光学補償素子３４は、液晶パネル３２内の液晶層における光の入射側領域の液晶分子によって生ずる光学的な位相差を補償する機能を有している。

【００３０】ここで、液晶パネル３２が、本発明における「液晶表示素子」の一具体例に対応する。また、光学補償素子３４が、本発明における「第１の光学補償素子」の一具体例に対応し、光学補償素子３３が、本発明における「第２の光学補償素子」の一具体例に対応する。なお、光学補償素子３４は、図２に示した位置に限定されず、液晶パネル３２と出射側偏光板３５との間であれば、任意の位置に配置可能である。すなわち、光学補償素子３４が、液晶パネル３２と光学補償素子３３との間に配置されていても良い。また、図２では、光学補償素子３３，３４が互いに離間した状態となっているが、光学補償素子３３，３４が互いに密着した状態となっていても良い。さらに、光学補償素子３３，３４が、それぞれ他の光学要素と密着した状態となっていても良い。例えば光学補償素子３３と液晶パネル３２とが密着した状態であっても良い。

【００３１】図3は、液晶パネル３２の詳細な構成を表すものである。液晶パネル３２は、画素電極基板４０ｂと、この画素電極基板４０ｂの光の入射面側に、液晶層４４を介して対向配設された対向基板４０ａとを備えている。

【００３２】画素電極基板４０ｂは、ガラス基板４７と、このガラス基板４７の光の入射面側に積層された複数の画素電極部４５および複数のブラックマトリクス部４６とを有している。画素電極基板４０ｂは、また、画素電極部４５およびブラックマトリクス部４６と液晶層４４との間に積層された配向膜４９を有している。各画素電極部４５は、導電性を有した透明な部材によって構成されている。ブラックマトリクス部４６は、隣り合う画素電極部４５の間に形成されている。各ブラックマトリクス部４６は、例えば金属膜等により遮光されている。ブラックマトリクス部４６の内部には、隣接する画素電極部４５に対して、画像信号に応じて選択的に電圧を印加するための図示しないスイッチング素子が形成されている。画素電極部４５に電圧を印加するためのスイッチング素子としては、例えば、薄膜トランジスタ（ＴＦＴ；Thin Film Transistor）が使用される。

【００３３】配向膜４９の液晶層４４に接する側の面は、液晶層４４における光の出射側領域（配向膜４９との界面付近）に存在する液晶分子の配列方向を揃えるために、ラビング処理が施されている。ラビング処理は、一般的に、布を巻いたローラで配向膜４９の表面を擦る

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(22)Date of filing : 28.06.2000 (72)Inventor : TANIMOTO TAKESHI

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(54) PROJECTION LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a projection liquid crystal display device having an improved a black level display and displaying a picture with contrast higher than that obtained by the conventional device.

SOLUTION: Arranging an optical compensation element 34 on the light emission side with respect to a liquid crystal panel 32 carries out optical compensation for liquid crystal molecules existing in the light incidence side region of a liquid crystal layer. Since the optical compensation element 34 is arranged on the light emission side with respect to the liquid crystal panel 32, birefringence generated by the liquid crystal molecules existing in the light incident side region is canceled without being affected by a micro lens 42 arranged on the liquid crystal panel 32. Thereby the black level display is improved and the picture with contrast higher than that obtained by the conventional device is displayed without being affected by the micro lens 42.

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3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The light source which emits the light needed for image display, and by having the liquid crystal layer from which two or more liquid crystal molecules were arranged in the distorted condition, and impressing an electrical potential difference to said liquid crystal layer selectively according to a picture signal The liquid crystal display component of the transparency mold which modulates the light which the array condition of said liquid crystal molecule is changed, and penetrates said liquid crystal layer, The 1st optical compensation component which compensates the optical phase contrast which it is prepared in the outgoing radiation side of light to said liquid crystal display component, and is produced with the liquid crystal molecule in the incidence side field of the light of said liquid crystal layer, The projection mold liquid crystal display characterized by having the projector lens which projects the light modulated by said liquid crystal display component.

[Claim 2] Said 1st optical compensation component is a projection mold liquid crystal display according to claim 1 characterized by being constituted including the matter which has the birefringence equivalent to the birefringence which

negative crystal has.

[Claim 3] As each liquid crystal molecule goes to a core from the incidence side field of light, and an outgoing radiation side field in said liquid crystal layer, where an electrical potential difference is impressed The molecule major axis receives the plane of incidence of light. From the condition near parallel or it It is that from which an array condition changes so that it may be in the vertical or condition near it to the plane of incidence of light. Said 1st optical compensation component Corresponding to the array condition of the liquid crystal molecule in the condition of having impressed the electrical potential difference, two or more molecules which constitute the matter which has said birefringence The projection mold liquid crystal display according to claim 2 characterized by being arranged so that the optical axis may change from the vertical or condition near it to the condition near parallel or it to the plane of incidence of light to the plane of incidence of light as it goes to an outgoing radiation side from the incidence side of light.

[Claim 4] Furthermore, the projection mold liquid crystal display according to claim 1 characterized by having the 2nd optical compensation component which compensates the optical phase contrast produced with the liquid crystal molecule in the outgoing radiation side field of the light of said liquid crystal layer including the matter which has the birefringence equivalent to the birefringence

which it is prepared in the outgoing radiation side of light to said liquid crystal display component, and negative crystal has.

[Claim 5] As each liquid crystal molecule goes to a core from the incidence side field of light, and an outgoing radiation side field in said liquid crystal layer, where an electrical potential difference is impressed The molecule major axis receives the plane of incidence of light. From the condition near parallel or it It is that from which an array condition changes so that it may be in the vertical or condition near it to the plane of incidence of light. Said 2nd optical compensation component Corresponding to the array condition of the liquid crystal molecule in the condition of having impressed the electrical potential difference, two or more molecules which constitute the matter which has said birefringence The projection mold liquid crystal display according to claim 4 characterized by being arranged so that the optical axis may change from the vertical or condition near it to the condition near parallel or it to the plane of incidence of light to the plane of incidence of light as it goes to an incidence side from the outgoing radiation side of light.

[Claim 6] The projection mold liquid crystal display according to claim 1 characterized by preparing two or more micro lenses which make the light which carried out incidence condense to said liquid crystal layer side in the incidence side of the light of said liquid crystal layer.

[Claim 7] Furthermore, it is the projection mold liquid crystal display according to claim 1 which is equipped with the polarizer of the couple which has the relation of a crossed Nicol mutually arranged to said liquid crystal display component at the incidence [of light], and outgoing radiation side, and is characterized by preparing said 1st optical compensation component between the polarizer arranged at the outgoing radiation side of light, and said liquid crystal display component.

[Claim 8] Furthermore, the projection mold liquid crystal display according to claim 1 characterized by having the 3rd optical compensation component which compensates the optical phase contrast produced with the liquid crystal molecule which is prepared in the outgoing radiation side of light to said liquid crystal display component, and exists in the field except the incidence side field of light, and an outgoing radiation side field among said liquid crystal layers.

[Claim 9] Said 3rd optical compensation component is a projection mold liquid crystal display according to claim 8 characterized by being constituted including the matter which has the birefringence equivalent to the birefringence which negative 1 axial crystal has.

[Claim 10] Each liquid crystal molecule in said liquid crystal layer has the birefringence equivalent to the birefringence which forward 1 axial crystal has, and in said liquid crystal layer, where an electrical potential difference is

impressed As it goes to a core from the incidence side field of light, and an outgoing radiation side field the molecule major axis It is that to which an array condition changes from the condition near parallel or it to the plane of incidence of light so that it may be in the vertical or condition near it to the plane of incidence of light. Said 3rd optical compensation component As opposed to the liquid crystal molecule with which the molecule major axis was vertically arranged to the plane of incidence of light The matter which has the function to compensate the optical phase contrast produced when light carries out incidence to the molecule major axis from across, and has the birefringence which constitutes said 3rd optical compensation component The projection mold liquid crystal display according to claim 9 characterized by being arranged so that the optical axis may become the molecule major axis of the liquid crystal molecule which serves as an object for compensation where an electrical potential difference is impressed to said liquid crystal layer, and parallel.

[Claim 11] The projection mold liquid crystal display according to claim 8 characterized by preparing two or more micro lenses which make the light which carried out incidence condense to said liquid crystal layer side in the incidence side of the light of said liquid crystal layer.

[Claim 12] Furthermore, it is the projection mold liquid crystal display according to claim 8 which is equipped with the polarizer of the couple which has the

relation of a crossed Nicol mutually arranged to said liquid crystal display component at the incidence [of light], and outgoing radiation side, and is characterized by preparing said 1st optical compensation component and the 2nd optical compensation component between the polarizer arranged at the outgoing radiation side of light, and said liquid crystal display component.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the projection mold liquid crystal display which displayed the image using the liquid crystal display component.

[0002]

[Description of the Prior Art] Conventionally, the light in which light modulation was carried out by the liquid crystal display component (henceforth a liquid crystal panel) is projected on a screen, and there is a projection mold liquid crystal display (liquid crystal projector) which displayed the image. As a projection method of the image in a projection mold liquid crystal display, there are a front projection type (front type) which projects an image from the

front-face side of a screen, and a tooth-back projection type (rear type) which projects an image from the tooth-back side of a screen. Moreover, in a projection mold liquid crystal display, the veneer method which uses one liquid crystal panel, and red (Red=R) and 3 plate methods using green (Green=G) and the liquid crystal panel of three sheets corresponding to three blue (Blue=B) colored light are one of those which perform color display.

[0003] In the projection mold liquid crystal display, many liquid crystal panels of TN (Twisted Nematic; it can twist and nematic) mold are used. The liquid crystal panel of TN mold encloses a nematic liquid crystal in the distorted condition between two substrates. A nematic liquid crystal consists of a molecule of the shape of two or more rod, and is arranged in the condition of having gathered in the direction where the molecule major axis is fixed. Moreover, the nematic liquid crystal has the birefringence which is generally equivalent to the birefringence which forward 1 axial crystal has. In this case, the direction of the optical axis of a liquid crystal molecule becomes the same as that of the direction of a molecule major axis. in the liquid crystal panel of TN mold, while arranging so that two substrates may be alike, respectively, and a molecule major axis may receive and may become parallel, it faces to the substrate of another side from one substrate -- as it was alike, it followed and 90 degrees of molecule major axes changed into the distorted condition, the nematic liquid crystal is enclosed. If

light carries out incidence by the normal state which does not impress an electrical potential difference to the liquid crystal panel of such a TN mold, optical activity will arise and the 90 degrees of the oscillating directions of light will be rotated by torsion of liquid crystal in accordance with torsion of liquid crystal. On the other hand, if an electrical potential difference is impressed to the liquid crystal panel of TN mold, the array condition of a liquid crystal molecule will change so that a molecule major axis may become vertical to a substrate, and optical activity will be lost. Therefore, the light which carried out incidence in this condition penetrates a liquid crystal panel in the condition that the oscillating direction is fixed.

[0004] Drawing 13 expresses the example of a configuration of the liquid crystal panel periphery in a projection mold liquid crystal display. In this example of a configuration, to the liquid crystal panel 101, the incidence side polarizing plate 102 is arranged at the incidence side of light, and the outgoing radiation side polarizing plate 103 is arranged at the outgoing radiation side of light. A liquid crystal panel 101 is the thing of a transparency mold which used TN liquid crystal, and has enclosed the nematic liquid crystal in the distorted condition between two substrates which the interior does not illustrate. The incidence side polarizing plate 102 and the outgoing radiation side polarizing plate 103 are arranged so that the transparency shaft of light may serve as relation of the

so-called crossed Nicol which intersected perpendicularly mutually. The transparency shaft of the incidence side polarizing plate 102 is set up so that it may become the array direction of the liquid crystal molecule in the substrate front face by the side of the incidence of a liquid crystal panel 101, and the same direction. On the other hand, the transparency shaft of the outgoing radiation side polarizing plate 103 is set up so that it may become the array direction of the liquid crystal molecule in the substrate front face by the side of the outgoing radiation of a liquid crystal panel 101, and the same direction.

[0005] In such a configuration, if the exposure light L0 from the light source which is not illustrated to the incidence side polarizing plate 102 carries out incidence, only the same linearly polarized light component 111 of the oscillating direction as the transparency shaft of the incidence side polarizing plate 102 will penetrate the incidence side polarizing plate 102. On the other hand, a part for Mitsunari 112 of the oscillating direction which intersects perpendicularly with the transparency shaft of the incidence side polarizing plate 102 is absorbed by the incidence side polarizing plate 102, and is not penetrated. Next, incidence of the part for Mitsunari 111 which penetrated the incidence side polarizing plate 102 is carried out to a liquid crystal panel 101.

[0006] Here, when it is the normal state which is not impressing the electrical potential difference to a liquid crystal layer in a liquid crystal panel 101, optical

activity arises and the 90 degrees of the oscillating directions of light are rotated by torsion of liquid crystal in accordance with torsion of liquid crystal. Thereby, the oscillating direction becomes in the same direction as the transparency shaft of the outgoing radiation side polarizing plate 103, and the light which carried out outgoing radiation of the liquid crystal panel 101 penetrates the outgoing radiation side polarizing plate 103. It is projected on the light which penetrated the outgoing radiation side polarizing plate 103 by the screen through the incident light study system which is not illustrated. At this time, the display condition of an image serves as the so-called display of a white level. On the other hand, in the energization condition of impressing the electrical potential difference to a liquid crystal layer in a liquid crystal panel 101, the array condition of a liquid crystal molecule changes so that the molecule major axis may serve as the same direction as an optical axis 100, and optical activity is lost. Therefore, as shown in drawing 13 , the linearly polarized light component 111 which penetrated the incidence side polarizing plate 102 carries out outgoing radiation of the liquid crystal panel 101, where the oscillating direction is maintained. The light which carried out outgoing radiation where this oscillating direction is maintained is absorbed by the outgoing radiation side polarizing plate 103, and is not penetrated. At this time, the display condition of an image serves as the so-called display of black level. Thus, generally in the liquid crystal

panel, the means of displaying which is made to penetrate light by the normal state which does not impress an electrical potential difference to a liquid crystal layer, and displays a white level is called the "normally white."

[0007]

[Problem(s) to be Solved by the Invention] By the way, in the example of a configuration shown in drawing 13 , in order to display ideal black level, the oscillating direction needs to carry out outgoing radiation only of the linearly polarized light component 111 which intersects perpendicularly with the transparency shaft of the outgoing radiation side polarizing plate 103 from a liquid crystal panel 101 in an energization condition. However, the amount of [of the oscillating direction which intersects perpendicularly with the linearly polarized light component 111 in an energization condition / 113] Mitsunari generates with the property of a liquid crystal panel 101 actually (refer to drawing 2). Since the oscillating direction is the transparency shaft and this direction of the outgoing radiation side polarizing plate 103, the amount of [which was generated here / 113] Mitsunari penetrates the outgoing radiation side polarizing plate 103 as it is. Although the optical reinforcement for this Mitsunari 113 is small compared with a part for Mitsunari 112 of the same oscillating direction absorbed with the incidence side polarizing plate 102, there is a possibility of degrading the display of black level enough. Since degradation of

such a black level display causes lowering of the contrast in image display, it poses a problem. In addition, the magnitude of the graphic form of a circle configuration expresses typically the size relation of the optical reinforcement for Mitsunari 112 and 113 which intersect perpendicularly with the linearly polarized light component 111 in drawing 14 .

[0008] Here, why outgoing radiation of the part for unnecessary Mitsunari is carried out from a liquid crystal panel 101 in an energization condition is explained briefly. In addition, below, it explains as what has the birefringence as forward 1 axial crystal with the same liquid crystal molecule. If it is arranged so that the molecule major axis of a liquid crystal molecule may serve as the same direction as an optical axis 100 in all the fields of a liquid crystal layer in an energization condition, about the light which carries out incidence to an optical axis 100 at parallel, it is in the condition which maintained the oscillating direction, and outgoing radiation of the liquid crystal panel 101 can be carried out. However, it is rare to be arranged in an energization condition, generally, so that the liquid crystal molecule in all fields may serve as the same direction as an optical axis 100. Also in the energization condition, an array condition does not change enough but especially the liquid crystal molecule that exists near the interface of a liquid crystal layer is in the condition that the molecule major axis inclined to the optical axis 100. Therefore, the light which carried out incidence to

the liquid crystal layer is changed with the liquid crystal molecule which exists near an interface, i.e., the liquid crystal molecule in the incidence side field of the light in a liquid crystal layer, and an outgoing radiation side field, to the oscillating direction of light. Thus, when the amount of unnecessary Mitsunari generates in a liquid crystal panel 101, the light of the linearly polarized light which carried out incidence turns into elliptically polarized light, and outgoing radiation will be carried out to a liquid crystal panel 101.

[0009] On the other hand, it is known for the field of the so-called liquid crystal display of a direct viewing type that there is a problem to which the transparency condition of light changes and the display grace of an image falls in the condition of having seen the liquid crystal panel from across, conventionally for the birefringence of a liquid crystal molecule. Generally this problem is called the angle-of-visibility dependency. In the field of the liquid crystal display of a direct viewing type, the optical compensation component for improving this angle-of-visibility dependency in recent years is developed. Then, it is possible to improve contrast using the optical compensation component currently developed for [of such a direct viewing type] liquid crystal displays for a projection mold liquid crystal display.

[0010] Drawing 15 shows the example of a configuration at the time of applying an above-mentioned optical compensation component to a projection mold liquid

crystal display. The example of a configuration shown in drawing 15 is the same as that of the configuration substantially shown in drawing 13 except having the optical compensation component 104,105. As shown in drawing 15 , the optical compensation component 104 is arranged between the incidence side polarizing plate 102 and the liquid crystal panel 101. The optical compensation component 105 is arranged between the liquid crystal panel 101 and the outgoing radiation side polarizing plate 103. The optical compensation component 104 has the function to compensate the optical phase contrast produced with the liquid crystal molecule of the incidence side field of the light in a liquid crystal layer. On the other hand, the optical compensation component 105 has the function to compensate the optical phase contrast produced with the liquid crystal molecule of the outgoing radiation side field of the light in a liquid crystal layer.

[0011] In such a configuration, when the linearly polarized light component 111 which carried out outgoing radiation from the incidence side polarizing plate 102 carried out incidence to the optical compensation component 104, as the operation of the optical compensation component 104 illustrated, the amount of [of the oscillating direction which intersects perpendicularly with the linearly polarized light component 111 / 114] Mitsunari generates. Next, incidence of a part for Mitsunari 114 and the linearly polarized light component 111 which carried out outgoing radiation from the optical compensation component 104 is

carried out to a liquid crystal panel 101. When a liquid crystal panel 101 is in an energization condition, the light which carried out incidence is first changed only into the linearly polarized light component 111 by the birefringence of the liquid crystal molecule which exists in the incidence side field of the light of a liquid crystal layer. Thus, the optical compensation component 104 compensates the optical phase contrast produced with the liquid crystal molecule of the incidence side field of the light in a liquid crystal layer as a result.

[0012] The amount of [of the oscillating direction where it intersects perpendicularly with the linearly polarized light component 111 further by the birefringence of the liquid crystal molecule which exists in an outgoing radiation side field if the light of the linearly polarized light component 111 penetrates the outgoing radiation side field of the light of a liquid crystal layer / 115] Mitsunari generates again. As illustrated, it becomes only the linearly polarized light component 111, and outgoing radiation of the light of a part for Mitsunari 115 and the linearly polarized light component 111 by which outgoing radiation was carried out from the liquid crystal panel 101 is carried out by operation of the optical compensation component 105. Thus, the optical compensation component 105 compensates the optical phase contrast produced with the liquid crystal molecule of the outgoing radiation side field of the light in a liquid crystal layer. That outgoing radiation is carried out becomes only the linearly polarized

light component 111 which intersects perpendicularly with the transparency shaft of the outgoing radiation side polarizing plate 103 from the optical compensation component 105 by this, and it is absorbed with the outgoing radiation side polarizing plate 103. Degradation of a black level display is prevented by the optical compensation component 104,105 as mentioned above, and a contrast improvement can be made.

[0013] If it is generally set up so that whenever [incident angle / of the light which carries out incidence to an optical compensation component] may become the same as that of whenever [incident angle / of the light which carries out incidence to the liquid crystal field which it is going to compensate] when using an optical compensation component, ideal optical compensation can be performed. However, a micro lens is arranged at the liquid crystal panel used for a projection mold liquid crystal display in many cases for improvement in aperture efficiency and improvement in color purity to the incidence side field of light. Thus, if other optical elements are arranged between an optical compensation component and a liquid crystal panel, a difference will arise in whenever [incident angle / of the light to an optical compensation component], and, whenever [incident angle / of the light which carries out incidence to a liquid crystal field]. If it will be in such a condition, the problem of it becoming impossible to perform sufficient optical compensation, and causing lowering of

contrast by the optical compensation component will arise.

[0014] This invention was made in view of this trouble, and the object improves the display of black level and is to offer the projection mold liquid crystal display which can perform high image display of contrast compared with the former.

[0015]

[Means for Solving the Problem] The projection mold liquid crystal display by this invention the light source which emits the light needed for image display, and by having the liquid crystal layer from which two or more liquid crystal molecules were arranged in the distorted condition, and impressing an electrical potential difference to a liquid crystal layer selectively according to a picture signal The liquid crystal display component of the transparency mold which modulates the light which the array condition of a liquid crystal molecule is changed and penetrates a liquid crystal layer, It was prepared in the outgoing radiation side of light to the liquid crystal display component, and has the projector lens which projects the light modulated by the 1st optical compensation component and liquid crystal display component which compensates the optical phase contrast produced with the liquid crystal molecule in the incidence side field of the light of a liquid crystal layer.

[0016] In addition, as for the 1st optical compensation component, in the projection mold liquid crystal display by this invention, it is desirable to be

constituted including the matter which has the birefringence equivalent to the birefringence which negative crystal has. Moreover, as for the projection mold liquid crystal display by this invention, it is desirable to have further the 2nd optical compensation component which compensates the optical phase contrast which it is prepared in the outgoing radiation side of light to a liquid crystal display component, and is produced with the liquid crystal molecule in the outgoing radiation side field of the light of a liquid crystal layer.

[0017] Moreover, as for the projection mold liquid crystal display by this invention, it is desirable to have further the 3rd optical compensation component which compensates the optical phase contrast produced with the liquid crystal molecule which is prepared in the outgoing radiation side of light to a liquid crystal display component, and exists in the field except the incidence side field of light and an outgoing radiation side field among liquid crystal layers. As for the 3rd optical compensation component, it is desirable to be constituted with the matter which has the birefringence equivalent to the birefringence which negative 1 axial crystal has. The 3rd optical compensation component is in the condition which has the birefringence by which each liquid crystal molecule for example, in a liquid crystal layer is equivalent to the birefringence which forward 1 axial crystal has, and impressed the electrical potential difference. The molecule major axis receives the plane of incidence of light as it goes to a core

from the incidence side field of light. From the condition near parallel or it When being arranged so that it may be in the vertical or condition near it to the plane of incidence of light, and an array condition may change, the optical phase contrast produced with the liquid crystal molecule with which the molecule major axis was vertically arranged to the plane of incidence of light is compensated. As for the matter which has the birefringence which constitutes the 3rd optical compensation component, at this time, it is desirable to be arranged so that that optical axis may become the molecule major axis of the liquid crystal molecule which serves as an object for compensation where an electrical potential difference is impressed to a liquid crystal layer, and parallel.

[0018] The optical phase contrast produced with the liquid crystal molecule in the incidence side field of the light of a liquid crystal layer is compensated with the projection mold liquid crystal display by this invention by the 1st optical compensation component prepared in the outgoing radiation side of light to the liquid crystal display component.

[0019] moreover, in the projection mold liquid crystal display by this invention By for example, the 3rd optical compensation component constituted with the matter which has the birefringence equivalent to the birefringence which negative 1 axial crystal has For example, where it has the birefringence by which each liquid crystal molecule in a liquid crystal layer is equivalent to the

birefringence which forward 1 axial crystal has and an electrical potential difference is impressed When being arranged so that a molecule major axis may become vertical to the plane of incidence of light as it goes to a core from the incidence side field of light, the optical phase contrast produced with the liquid crystal molecule with which the molecule major axis was arranged vertically is compensated.

[0020]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to a drawing.

[0021] [Gestalt of the 1st operation] drawing 1 shows the whole projection mold liquid crystal display configuration concerning the gestalt of operation of the 1st of this invention. The projection mold liquid crystal display shown in this drawing is a thing of 3 plate methods which performs three color picture displays using the liquid crystal panel of a transparency mold. This projection mold liquid crystal display is equipped with the light source 11, the UV (ultraviolet rays) / IR (infrared radiation) cut-off filter 12, the fly eye lenses 13 and 14, the condenser lens 15, and the dichroic mirror 16 in order in accordance with the optical axis 10.

[0022] The light source 11 emits the white light containing the red light, blue glow, and green light which are needed for a color picture display. This light source 11 is constituted including emitter 11a which emits the white light, and concave

mirror 11b which reflects the light emitted from emitter 11a, and condenses. As emitter 11a, a halogen lamp, a metal halide lamp, or a xenon lamp is used, for example. As for concave mirror 11b, it is desirable that it is a configuration with condensing sufficient effectiveness the field configuration of an ellipsoid-of-revolution mirror, a paraboloid-of-revolution mirror, etc. symmetrical with a revolution.

[0023] The UV/IR cut-off filter 12 has the function to remove the light of ultraviolet [which is contained in the white light emitted from the light source 11], and an infrared region. The fly eye lenses 13 and 14 have the function which is made to diffuse the light which penetrated UV / IR cut-off filter 12, and equalizes the illuminance distribution of light. The dichroic mirror 16 has the function to divide into the red light LR and other colored light the light which carried out incidence through the UV/IR cut-off filter 12, the fly eye lenses 13 and 14, and a condenser lens 15.

[0024] This projection mold liquid crystal display is equipped with a total reflection mirror 17, condenser lens 23R, and liquid crystal panel section 24R in order again in accordance with the optical path of the red light LR separated with the dichroic mirror 16. A total reflection mirror 17 turns to liquid crystal panel section 24R the red light LR separated with the dichroic mirror 16, and reflects it. Condenser lens 23R condenses the red light LR reflected by the dichroic mirror

16 to liquid crystal panel section 24R. Liquid crystal panel section 24R has the function which modulates spatially the red light LR which carried out incidence through a total reflection mirror 17 and condenser lens 23R according to a picture signal.

[0025] This projection mold liquid crystal display is further equipped with the dichroic mirror 18 in accordance with the optical path of other colored light separated with the dichroic mirror 16. The dichroic mirror 18 has the function to divide into green light and blue glow the light which carried out incidence.

[0026] This projection mold liquid crystal display is equipped with condenser lens 23G and liquid crystal panel section 24G in order again in accordance with the optical path of the green light LG separated with the dichroic mirror 18. Condenser lens 23G condense the green light LG separated with the dichroic mirror 18 to liquid crystal panel section 24G. Liquid crystal panel section 24G have the function which modulates spatially the green light LG which carried out incidence through condenser lens 23G according to a picture signal.

[0027] This projection mold liquid crystal display is further equipped with a relay lens 19, a total reflection mirror 20, a relay lens 21, a total reflection mirror 22, condenser lens 23B, and liquid crystal panel section 24B in order in accordance with the optical path of the blue glow LB separated with the dichroic mirror 18. It is separated by the dichroic mirror 18, and a total reflection mirror 20 turns to a

total reflection mirror 22 the blue glow LB which carried out incidence through the relay lens 19, and reflects it. It is reflected by the total reflection mirror 20, and a total reflection mirror 22 turns to liquid crystal panel section 24B the blue glow LB which carried out incidence through the relay lens 21, and reflects it. It is reflected by the total reflection mirror 22 and liquid crystal panel section 24B has the function which modulates spatially the blue glow LB which carried out incidence through condenser lens 23B according to a picture signal.

[0028] This projection mold liquid crystal display equips the location at which the optical path of the red light LR, green light LG, and blue glow LB crosses with the dichroic prism 25 with the function which compounds three colored light LR, LG, and LB again. This projection mold liquid crystal display is equipped with the projector lens 26 for turning and projecting a synthetic light by which outgoing radiation was carried out on a screen 27 from a dichroic prism 25 again. The dichroic prism 25 has three plane of incidence 25R, 25G, and 25G and one outgoing radiation side 25T. The red light LR by which outgoing radiation was carried out from liquid crystal panel section 24R carries out incidence to plane-of-incidence 25R. The green light LG by which outgoing radiation was carried out from liquid crystal panel section 24G carries out incidence to plane-of-incidence 25G. The blue glow LB by which outgoing radiation was carried out from liquid crystal panel section 24B carries out incidence to

plane-of-incidence 25B. A dichroic prism 25 compounds three colored light which carried out incidence to plane of incidence 25R, 25G, and 25G, and it carries out outgoing radiation from outgoing radiation side 25T.

[0029] Drawing 2 expresses the important section configuration of the liquid crystal panel section. It is only that the components of light used as the object for a modulation differ, and the function and the configuration of the liquid crystal panel sections 24R, 24G, and 24B are substantially the same. Below, the configuration of the panel section for each colors is explained collectively. As shown in drawing 2 , the liquid crystal panel section 24 (24R, 24G, 24B) has the incidence side polarizing plate 31, a liquid crystal panel 32, the optical compensation components 33 and 34, and the outgoing radiation side polarizing plate 35 sequentially from the incidence side of light. The plane of incidence and the outgoing radiation side of light in each optical element of the liquid crystal panel section 24 lie at right angles to an optical axis 10. A liquid crystal panel 32 is the thing of a transparency mold which used TN liquid crystal, and the nematic liquid crystal is enclosed with the interior in the distorted condition. The incidence side polarizing plate 31 and the outgoing radiation side polarizing plate 35 penetrate only the linearly polarized light light of the predetermined oscillating direction among the light which carried out incidence. The optical compensation component 33 has the function to compensate the optical phase contrast

produced with the liquid crystal molecule of the outgoing radiation side field of the light in the liquid crystal layer in a liquid crystal panel 32. On the other hand, the optical compensation component 34 has the function to compensate the optical phase contrast produced with the liquid crystal molecule of the incidence side field of the light in the liquid crystal layer in a liquid crystal panel 32.

[0030] Here, a liquid crystal panel 32 corresponds to one example of the "liquid crystal display component" in this invention. Moreover, the optical compensation component 34 corresponds to one example of "the 1st optical compensation component" in this invention, and the optical compensation component 33 corresponds to one example of "the 2nd optical compensation component" in this invention. In addition, the optical compensation component 34 is not limited to the location shown in drawing 2 , but if it is between a liquid crystal panel 32 and the outgoing radiation side polarizing plate 35, it can be arranged in the location of arbitration. That is, the optical compensation component 34 may be arranged between the liquid crystal panel 32 and the optical compensation component 33. Moreover, although the optical compensation components 33 and 34 are in the condition of having estranged mutually, in drawing 2 , the optical compensation components 33 and 34 may be in the condition of having stuck mutually. Furthermore, the optical compensation components 33 and 34 may be in the condition of having stuck with other optical elements, respectively.

For example, you may be in the condition which the optical compensation component 33 and the liquid crystal panel 32 stuck.

[0031] Drawing 3 expresses the detailed configuration of a liquid crystal panel 32. The liquid crystal panel 32 is equipped with pixel electrode substrate 40b and opposite substrate 40a by which opposite arrangement was carried out through the liquid crystal layer 44 at the plane-of-incidence side of the light of this pixel electrode substrate 40b.

[0032] Pixel electrode substrate 40b has a glass substrate 47, and two or more pixel polar zone 45 and two or more black matrix sections 46 by which the laminating was carried out to the plane-of-incidence side of the light of this glass substrate 47. Pixel electrode substrate 40b has the orientation film 49 by which the laminating was carried out between the pixel polar zone 45 and the black matrix section 46, and the liquid crystal layer 44 again. Each pixel polar zone 45 is constituted by the transparent member with conductivity. The black matrix section 46 is formed between the adjacent pixel polar zone 45. Each black matrix section 46 is shaded by the metal membrane etc. The switching element which is not illustrated for impressing an electrical potential difference selectively according to a picture signal is formed in the interior of the black matrix section 46 to the adjoining pixel polar zone 45. As a switching element for impressing an electrical potential difference to the pixel polar zone 45, a thin film transistor

(TFT;Thin Film Transistor) is used, for example.

[0033] Rubbing processing is performed in order that the field of the side which touches the liquid crystal layer 44 of the orientation film 49 may arrange the array direction of the liquid crystal molecule which exists in the outgoing radiation side field (near an interface with the orientation film 49) of the light in the liquid crystal layer 44. Rubbing processing is performed by generally grinding the front face of the orientation film 49 against the roller around which cloth was wound. By performing rubbing processing to the orientation film 49, two or more slots are formed in the front face of the orientation film 49 in the same direction. Orientation of the liquid crystal molecule of the field which touches the orientation film 49 is carried out in the fixed direction along the slot minced by the front face of the orientation film 49. Below, the direction of the slot minced by performing this rubbing processing is called "direction of rubbing."

[0034] Opposite substrate 40a has a glass substrate 41, a micro lens 42, a counterelectrode 43, and the orientation film 48 sequentially from the incidence side of light. The orientation film 48 is arranged so that the field by the side of the outgoing radiation of light may touch the liquid crystal layer 44. In order that the field of the side which touches the liquid crystal layer 44 of the orientation film 48 may arrange the array direction of the liquid crystal molecule which exists in the incidence side field (near an interface with the orientation film 48) of the light in

the liquid crystal layer 44, rubbing processing is performed by the same technique as the orientation film 49 of pixel electrode substrate 40b.

[0035] The laminating of the counterelectrode 43 is carried out to the field by the side of the incidence of the light in the orientation film 48. A counterelectrode 43 is for generating potential between the pixel polar zone 45, for example, is formed by transparence electric conduction film, such as ITO (Indium Tin Oxide). In addition, the counterelectrode 43 is usually being fixed to fixed potential (for example, touch-down potential). The laminating of the micro lens 42 is carried out to the field by the side of the incidence of the light of a counterelectrode 43. Two or more micro lenses 42 are formed corresponding to the pixel polar zone 45.

[0036] The incidence side of light is a convex configuration and, as for each micro lens 42, the outgoing radiation side of light serves as a flat-surface configuration. Each micro lens 42 has forward refractive power, and condenses the light which carried out incidence through the glass substrate 41 towards the corresponding pixel polar zone 45. for example, the plane of incidence of a liquid crystal panel 32 -- receiving -- being vertical (it being parallel to an optical axis 10) -- whenever [incident angle] is made to carry out incidence of the light L1 which carried out incidence to the liquid crystal layer 44 except for a part for Mitsunari which passes along the optical axis of each micro lens 42, after only

include-angle theta1b has inclined to an optical axis 10 by operation of each micro lens 42 moreover, an operation of each micro lens 42 carries out incidence of the light L2 which carried out incidence from across by include-angle theta2a an optical axis 10 -- receiving -- to the plane of incidence of a liquid crystal panel 32 to the liquid crystal layer 44 with different include-angle theta2b from include-angle theta2a. By forming the micro lens 42, the incidence effectiveness of the light to the pixel polar zone 45 can be raised.

[0037] Drawing 4 expresses the array condition of the liquid crystal molecule at the time of being the normal state by which the electrical potential difference is not impressed to the liquid crystal layer. In addition, in drawing 4 , a straight line parallel to an optical axis 10 is made into the z-axis, and two straight lines in the flat surface which intersects perpendicularly with the z-axis are made into x and the y-axis. The plane of incidence and the outgoing radiation side of light in the liquid crystal layer 44 become in parallel with xy flat surface. The nematic liquid crystal which consists of a liquid crystal molecule 50 of the shape of two or more rod is enclosed with the liquid crystal layer 44. Each liquid crystal molecule 50 is arranged so that an optical axis 10 and the molecule major axis may cross at right angles. That is, the molecule major axis of each liquid crystal molecule 50 is arranged by parallel to the plane of incidence and the outgoing radiation side of light. The direction R1 of rubbing of the orientation film 48 and the direction R2 of

rubbing of the orientation film 49 are set up so that it may intersect perpendicularly mutually. In the example of drawing 4 , the direction R1 of rubbing of the orientation film 48 is made into the direction of a x axis, and the direction R2 of rubbing of the orientation film 49 is made into y shaft orientations.

[0038] In the liquid crystal layer 44, the liquid crystal molecule which exists near an interface with the orientation film 48 is arranged in the same direction as the direction R1 of rubbing of the orientation film 48 according to an operation of the rubbing processing performed to the front face of the orientation film 48. Similarly, the liquid crystal molecule which exists near an interface with the orientation film 49 is mostly arranged in the same direction with the direction R2 of rubbing of the orientation film 49. Since the directions R1 and R2 of rubbing lie at right angles mutually, each liquid crystal molecule 50 is arranged so that 90 degrees of molecule major axes may be in a distorted condition, as it faces to the orientation film 49 from the orientation film 48 (i.e., as it goes to an outgoing radiation side from the incidence side of light). Thus, the nematic liquid crystal with which each liquid crystal molecule was arranged in the distorted condition is called TN liquid crystal. If light carries out incidence by the normal state which does not impress an electrical potential difference to TN liquid crystal, optical activity will arise and the 90 degrees of the oscillating directions of light will be rotated by torsion of liquid crystal along the direction of torsion of liquid crystal.

[0039] Drawing 5 expresses the array condition of the liquid crystal molecule when impressing an electrical potential difference with the liquid crystal layer. If an electrical potential difference is impressed to the liquid crystal layer 44, the array condition of the liquid crystal molecule 50 will change so that the condition in which the liquid crystal molecule 50 started, i.e., a molecule major axis, may be parallel (vertical to the plane of incidence of light) to an optical axis 10.

[0040] Here, ideally, it is in the condition which impressed the electrical potential difference, and it is desirable for an array condition to change so that all the liquid crystal molecules 50 in the liquid crystal layer 44 may become parallel to an optical axis 10. If it is in such an array condition, an optical axis 10 can be made to penetrate to parallel, the light which carried out incidence, while the oscillating direction has been fixed. However, actually, an array condition changes so that it may be in the condition that the molecule major axis started gradually, as the liquid crystal molecule 50 goes to the central field of the liquid crystal layer 44 from the orientation film 48 and 49 in an energization condition. Therefore, the liquid crystal molecule 50 near the interface of the liquid crystal layer 44 and the orientation film 48 and 49 is in the array condition toward which the molecule major axis inclined to the optical axis 10 rather than was parallel also in the energization condition. Thus, since the liquid crystal molecule 50 in the condition of having inclined to the optical axis 10 exists, if linearly polarized

light light carries out incidence to an optical axis 10 in an energization condition at parallel, since it is the birefringence of the liquid crystal molecule 50, phase contrast arises near an interface, it will become elliptically polarized light and outgoing radiation will be carried out. In the gestalt of this operation, the phase contrast produced near the interface of the liquid crystal layer 44 and the orientation film 48 and 49 in this way is optically compensated by the optical compensation components 33 and 34 (drawing 2).

[0041] Next, the structure and the function of the optical compensation components 33 and 34 are explained to a detail. The nematic liquid crystal molecule has the birefringence which is generally equivalent to the birefringence which positive crystal has. Therefore, the phase contrast produced by the birefringence of a nematic liquid crystal molecule can be compensated by using the matter which had the property of reverse optically [positive crystal], i.e., the matter with the birefringence equivalent to the birefringence which negative crystal has. It explains as what is constituted from below by the liquid crystal molecule which has the birefringence by which the liquid crystal layer 44 is equivalent to the birefringence which forward 1 axial crystal has, and is constituted with the matter which has the birefringence by which the optical compensation components 33 and 34 are equivalent to the birefringence which negative 1 axial crystal has.

[0042] Drawing 9 shows refractive-index distribution of forward 1 axial crystal, and drawing 10 shows refractive-index distribution of negative 1 axial crystal. In drawing 9 and drawing 10 , the refractive index of x and y which intersect perpendicularly mutually, and z shaft orientations is set to nx, ny, and nz, respectively. Moreover, z shaft orientations are made into the direction of an optical axis of a crystal in drawing 9 and drawing 10 . Refractive-index distribution of 1 axial crystal is expressed with the configuration of the spheroid which made the optical axis the center of rotation. Generally the spheroid showing this refractive-index distribution is called an index ellipsoid. As 1 axial crystal, the value (it is hereafter described as no.) of the refractive indexes nx and ny of x and y shaft orientations becomes equal so that the configuration of an index ellipsoid may show. Moreover, in 1 axial crystal, the light which carries out incidence in the direction of an optical axis does not show birefringence, but the light which carries out incidence in the direction of [other than an optical axis] shows birefringence. Here, if the value of the refractive index nz of z shaft orientations is set to ne, the relation of "ne>no" will be filled with the forward 1 axial crystal 51 (drawing 9), and the relation of "ne<no" will be filled with the negative 1 axial crystal 52 (drawing 10). Therefore, the index ellipsoid of the negative 1 axial crystal 52 becomes disc-like. The birefringence produced from the above optical properties in the light which carried out incidence by combining

forward 1 axial crystal which has suitable refractive-index distribution, and negative 1 axial crystal can be lost. By arranging proper at this time, for example, forward 1 axial crystal and negative 1 axial crystal, so that the direction of that optical axis may turn into the same direction, to the light which carried out incidence from the direction of arbitration, it can phase-kill and a birefringence can be canceled.

[0043] Drawing 7 expresses typically the relation between the array condition of the liquid crystal molecule which constitutes the liquid crystal layer 44, and the array condition of the internal matter which constitutes the optical compensation components 33 and 34 by the index ellipsoid. The array condition of the liquid crystal molecule shown in drawing 7 shows the thing in the condition of having impressed the electrical potential difference. In addition, the direction of the thing in which a liquid crystal molecule has a forward optically uniaxial optical property then its molecule major axis, and an optical axis is in agreement. The molecule major axis (optical axis) is in the array condition [like / (it will be in the condition near parallel or it to the optical axis 10)] of starting gradually as are already explained with reference to drawing 5 , and the liquid crystal molecule in an energization condition goes to the central field of the liquid crystal layer 44. In drawing 7 , three liquid crystal molecules 44a, 44b, and 44c with which an optical axis starts gradually exist in the incidence side field of light sequentially from the

orientation film 48 side. Moreover, three liquid crystal molecules 44f, 44e, and 44d with which an optical axis starts gradually exist in the outgoing radiation side field of light sequentially from the orientation film 49 side.

[0044] The matter which constitutes the optical compensation component 34 has the composition that it starts in the direction as the liquid crystal molecule (liquid crystal molecule which exists in the incidence side field of the light in the liquid crystal layer 44) used as the object for compensation where an index ellipsoid is the same. That optical axis will be in an array condition which will be in the condition (it is a condition near parallel or it to the plane of incidence of light) vertical to an optical axis 10 or near it gradually as it goes to an outgoing radiation side from the incidence side of light, if the matter which constitutes the optical compensation component 34 is negative 1 axial crystal at this time. The optical compensation component 34 is constituted from the example of drawing 7 by three molecules 34a, 34b, and 34c sequentially from the incidence side of light corresponding to three liquid crystal molecules 44c, 44b, and 44a of the liquid crystal layer 44. In the optical compensation component 34, the optical axis of molecule 34a serves as an optical axis of liquid crystal molecule 44c, and parallel, and the optical axis of molecule 34b serves as an optical axis of liquid crystal molecule 44b, and parallel. Moreover, in the optical compensation component 34, the optical axis of molecule 34c serves as an optical axis of liquid

crystal molecule 44a, and parallel. By making such molecular arrangement, optical compensation over liquid crystal molecule 44c is performed by molecule 34a in the optical compensation component 34, and optical compensation over liquid crystal molecule 44b is performed by molecule 34b in the optical compensation component 34. Moreover, optical compensation over liquid crystal molecule 44a is performed by molecule 34c in the optical compensation component 34.

[0045] On the other hand, the index ellipsoid has the composition that it starts in the same direction as the liquid crystal molecule (liquid crystal molecule which exists in the outgoing radiation side field of the light in the liquid crystal layer 44) used as the object for compensation, about the matter which constitutes the optical compensation component 33 as well as the optical compensation component 34. The optical compensation component 33 is constituted from the example of drawing 7 by three molecules 33a, 33b, and 33c sequentially from the incidence side of light corresponding to three liquid crystal molecules 44f, 44e, and 44d of the liquid crystal layer 44. In the optical compensation component 33, the optical axis of molecule 33a serves as an optical axis of 44f of liquid crystal molecules, and parallel, and the optical axis of molecule 33b serves as an optical axis of liquid crystal molecule 44e, and parallel. Moreover, in the optical compensation component 33, the optical axis of molecule 33c

serves as an optical axis of 44d of liquid crystal molecules, and parallel. By making such molecular arrangement, optical compensation over 44f of liquid crystal molecules is performed by molecule 33a in the optical compensation component 33, and optical compensation over liquid crystal molecule 44e is performed by molecule 33b in the optical compensation component 33. Moreover, optical compensation over 44d of liquid crystal molecules is performed by molecule 33c in the optical compensation component 33.

[0046] By the way, in the field of the liquid crystal display of a direct viewing type, the optical compensation component for improving an angle-of-visibility dependency is developed conventionally. As an optical compensation component for an angle-of-visibility improvement, it is Fuji Photo Film "Fuji WV Film, for example. There is wide view A" (henceforth "WV film"). after WV film's painting the polymer orientation film on a TAC (Tri-Acetyl Cellulose) film and performing rubbing processing -- further -- disco tic liquid crystal -- spreading and orientation -- structure immobilization is carried out and it is manufactured. With WV film, hybrid orientation (orientation from which the tilt angle of a liquid crystal molecule changes continuously in the thickness direction) of the disco tic liquid crystal molecule is carried out. The molecular structure has become disc-like and, generally disco tic liquid crystal has the optical property of negative crystal. It is thought that the disco tic liquid crystal molecule used with WV film

has the birefringence equivalent to the birefringence which negative 1 axial crystal has. Optical compensation of a liquid crystal panel can be performed by following, for example, applying to the liquid crystal panel using TN crystal. The structure and the manufacture approach of an optical compensation sheet equivalent to WV film are indicated by JP,7-333434,A, JP,8-5837,A, etc., for example. In these official reports, two or more concrete matter names of an usable disc-like compound are mentioned to the optical compensation sheet.

[0047] As optical compensation components 33 and 34 in the gestalt of this operation, it is possible to use above-mentioned WV film. That is, it is possible to use the disc-like compound indicated by JP,7-333434,A, JP,8-5837,A, etc. as matter with the property of the negative crystal which constitutes the optical compensation components 33 and 34. In addition, if the matter which constitutes the optical compensation components 33 and 34 has optically the property of the negative crystal which can be compensated not only for a thing given [above-mentioned] in an official report but for the liquid crystal in the liquid crystal layer 44, it can also use other matter.

[0048] Drawing 6 shows various kinds of shaft orientations between each optical element in the liquid crystal panel section 24. As shown in drawing 6 , the incidence side polarizing plate 31 and the outgoing radiation side polarizing plate 35 are arranged so that it may become the relation of the so-called crossed Nicol

relation and the transparency shafts P1 and P2 of a mutual light crossed at right angles. Moreover, the transparency shaft P1 of the incidence side polarizing plate 31 is set up so that it may become the direction R1 of rubbing of the orientation film 48 (drawing 3) in a liquid crystal panel 32, and the same direction. On the other hand, the transparency shaft P2 of the outgoing radiation side polarizing plate 35 is set up so that it may become the direction R2 of rubbing of the orientation film 49 (drawing 3) in a liquid crystal panel 32, and the same direction. That is, the means of displaying of the image in the liquid crystal panel section 24 has the so-called composition of a normally white. The optical compensation component 33 is arranged so that the direction of the optical axis P3 of the molecule (molecule 33a in drawing 7) which exists in the plane-of-incidence side of light may turn into mostly the direction R2 of rubbing of the orientation film 49 with the same direction. Moreover, the optical compensation component 34 is arranged so that the direction of the optical axis P4 of the molecule (molecule 34c in drawing 7) which exists in the outgoing radiation side side of light may turn into mostly the direction R1 of rubbing of the orientation film 48 with the same direction.

[0049] Next, an operation of the projection mold liquid crystal display of the above configurations is explained.

[0050] First, with reference to drawing 1 , an overall operation of a projection

mold liquid crystal display is explained. When the white light emitted from the light source 11 penetrates the UV/IR cut-off filter 12 first, the light of ultraviolet and an infrared region is removed. When the light which penetrated the UV/IR cut-off filter 12 penetrates the fly eye lenses 13 and 14 next, the illuminance distribution is equalized. Next, after the light which penetrated the fly eye lenses 13 and 14 penetrates a condenser lens 15, incidence of it is carried out to a dichroic mirror 16. The light which carried out incidence to the dichroic mirror 16 is separated into the red light LR and other colored light by operation of a dichroic mirror 16.

[0051] The red light LR separated with the dichroic mirror 16 is reflected by the total reflection mirror 17 towards liquid crystal panel section 24R. Incidence of the red light LR reflected by the total reflection mirror 17 is carried out to liquid crystal panel section 24R through condenser lens 23R. In liquid crystal panel section 24R, after becoming irregular spatially according to a picture signal, incidence of the red light LR which carried out incidence to liquid crystal panel section 24R is carried out to plane-of-incidence 25R of a dichroic prism 25.

[0052] On the other hand, next, incidence of the colored light of others which were separated with the dichroic mirror 16 is carried out to a dichroic mirror 18, and it is divided into green light LG and blue glow LB here. Incidence of the green light LG separated with the dichroic mirror 18 is carried out to liquid crystal

panel section 24G through condenser lens 23G. In liquid crystal panel section 24G, after becoming irregular spatially according to a picture signal, incidence of the green light LG which carried out incidence to liquid crystal panel section 24G is carried out to plane-of-incidence 25G of a dichroic prism 25.

[0053] Incidence of the blue glow LB separated with the dichroic mirror 18 is carried out to a total reflection mirror 20 through a relay lens 19, and it is reflected towards a total reflection mirror 22 here. Incidence of the blue glow LB reflected by the total reflection mirror 20 is carried out to a total reflection mirror 22 through a relay lens 21, and it is reflected towards liquid crystal panel section 24B here. Incidence of the blue glow LB reflected by the total reflection mirror 22 is carried out to liquid crystal panel section 24B through condenser lens 23B. In liquid crystal panel section 24B, after becoming irregular spatially according to a picture signal, incidence of the blue glow LB which carried out incidence to liquid crystal panel section 24B is carried out to plane-of-incidence 25B of a dichroic prism 25.

[0054] Three colored light LR, LG, and LB which carried out incidence to the dichroic prism 25 is compounded by operation of a dichroic prism 25, and outgoing radiation is carried out towards a projector lens 26 from outgoing radiation side 25T. With a projector lens 26, it is projected on a synthetic light by which outgoing radiation was carried out from the dichroic prism 25 at a

front-face [of a screen 27], or tooth-back side, and it forms an image on a screen 27.

[0055] Next, an operation of the liquid crystal panel section 24 is explained. If colored light LR, LG, and LB carries out incidence to the incidence side polarizing plate 31 (drawing 2), only the same linearly polarized light component of the oscillating direction as the transparency shaft P1 (drawing 6) will penetrate the incidence side polarizing plate 31. Next, incidence of the part for Mitsunari which penetrated the incidence side polarizing plate 31 is carried out to a liquid crystal panel 32. Incidence of most light which carried out incidence to the liquid crystal panel 32 is carried out to the liquid crystal layer 44 according to an operation of a micro lens 42 (drawing 3) at a different include angle from the outgoing radiation include angle to the incidence side polarizing plate 31.

[0056] Here, in the energization condition of impressing the electrical potential difference to the liquid crystal layer 44 in a liquid crystal panel 32, the molecule major axis will be in the array condition which started gradually as a liquid crystal molecule goes to the central field of the liquid crystal layer 44 from the orientation film 48 and 49 (drawing 5). In this condition, the light which carried out incidence to the liquid crystal layer 44 receives a birefringence mainly with the liquid crystal molecule which exists in the incidence side field of light, and the

liquid crystal molecule which exists in the outgoing radiation side field of light. Among these, the birefringence received with the liquid crystal molecule which exists in the outgoing radiation side field of light is offset and canceled by the optical compensation component 33. The birefringence received on the other hand with the liquid crystal molecule which exists in the incidence side field of light is offset and canceled by the optical compensation component 34. Thus, most light which carries out incidence to the outgoing radiation side polarizing plate 35 turns into only light which has the vertical oscillating direction to the transparency shaft P2 of the outgoing radiation side polarizing plate 35 by performing optical compensation by the optical compensation components 33 and 34. Since the light of this oscillating direction is absorbed with the outgoing radiation side polarizing plate 35 and penetrated, the display condition of an image serves as the so-called display of black level.

[0057] On the other hand, in the condition of not impressing the electrical potential difference to the liquid crystal layer 44, optical activity arises and the 90 degrees of the oscillating directions of light are rotated by torsion of liquid crystal in accordance with torsion of liquid crystal (drawing 4). Thereby, the oscillating direction becomes in the same direction as the transparency shaft P2 (drawing 6) of the outgoing radiation side polarizing plate 35, and the light which carried out outgoing radiation of the liquid crystal panel 32 penetrates the outgoing

radiation side polarizing plate 35 through the optical compensation components 33 and 34. It is projected on the light which penetrated the outgoing radiation side polarizing plate 35 by the screen 27 with a projector lens 26. At this time, the display condition of an image serves as the so-called display of a white level. In addition, the light which carried out outgoing radiation of the liquid crystal panel 32 in the condition of not impressing the electrical potential difference to the liquid crystal layer 44 receives the optical operation by the optical compensation components 33 and 34. However, there is little effect which the optical operation in this condition has on the display of a white level, and it does not pose a problem substantially in respect of image display.

[0058] Drawing 8 shows the example of a comparison over the liquid crystal panel section in the gestalt of this operation. In the example of a comparison shown in drawing 8 , the optical compensation component 34 is arranged between the incidence side polarizing plate 31 and a liquid crystal panel 32. In this case, optical compensation over the liquid crystal molecule which exists in the incidence side field of the light in the liquid crystal layer 44 in the phase before carrying out incidence to a liquid crystal panel 32 is performed. However, a difference will arise about almost all incident light in this case in whenever [to the optical compensation component 34 / incident angle], and, whenever [to the liquid crystal layer 44 / incident angle] according to the lens operation of a micro

lens 42 prepared in the liquid crystal panel 32. When a difference arises in whenever [incident angle], a gap arises in optical physical relationship with the liquid crystal molecule used as the matter which constitutes the optical compensation component 34, and the object for compensation, and it becomes impossible thus, to perform sufficient optical compensation. On the other hand, in the configuration of the liquid crystal panel section 24 in the gestalt of this operation shown in drawing 7 , since the optical compensation component 34 is formed in the outgoing radiation side of light to the liquid crystal panel 32, a difference does not arise in whenever [to the optical compensation component 34 / incident angle], and, whenever [to the liquid crystal layer 44 / incident angle], and sufficient optical compensation can be performed.

[0059] The birefringence produced with the liquid-crystal molecule which exists in the incidence side field of light can be canceled without being influenced of the micro lens 42 prepared in the liquid crystal panel 32, since it was made to perform optical compensation over the liquid-crystal molecule which forms the optical compensation component 34 in the outgoing radiation side of light to a liquid crystal panel 32, and exists in the incidence side field of the light in the liquid crystal layer 44 according to the gestalt of this operation as explained above. Thereby, without being influenced of a micro lens 42, the display of black level can be improved and high image display of contrast can be performed

compared with the former.

[0060] In addition, although the optical compensation component 33 is formed and not only the incidence side field of the light in the liquid crystal layer 44 but the optical phase contrast produced with the liquid crystal molecule of the outgoing radiation side field of light was compensated with the gestalt of this operation, you may make it form only the optical compensation component 34, without forming the optical compensation component 33. Also in this case, the birefringence produced with the liquid crystal molecule which exists in the incidence side field of the light in the liquid crystal layer 44 at least by the optical compensation component 34 is cancelable. Moreover, although the gestalt of this operation explained the case where the micro lens 42 was formed in the liquid crystal panel 32 to the example, this invention can be applied also when the micro lens 42 is not formed.

[0061] [The gestalt of the 2nd operation], next the gestalt of operation of the 2nd of this invention are explained. In addition, in the following explanation, the same sign is given to the same part as the component in the gestalt of implementation of the above 1st, and explanation is omitted suitably.

[0062] Drawing 11 expresses the important section configuration of the liquid crystal panel section in the projection mold liquid crystal display concerning the gestalt of operation of the 2nd of this invention. The configuration of the

projection mold liquid crystal display concerning the gestalt of this operation is the same as that of the gestalt of implementation of the above 1st except for the configuration of the liquid crystal panel section shown in drawing 11 . Moreover, also in the gestalt of this operation, in each color, since the function of the liquid crystal panel section and a configuration are substantially the same, they explain the configuration of the liquid crystal panel section for each colors collectively below. That liquid crystal panel section 24A (24R, 24G, 24B) in the gestalt of this operation differs from the liquid crystal panel section 24 shown in drawing 2 is the point that the optical compensation component 36 is formed between the optical compensation component 34 and the outgoing radiation side polarizing plate 35. The optical compensation component 36 has the function for compensating optically the birefringence produced with the liquid crystal molecule which exists in the interstitial segment of the liquid crystal layer 44. Here, the optical compensation component 36 corresponds to one example of "the 3rd optical compensation component" in this invention.

[0063] In addition, the optical compensation component 36 is not limited to the location shown in drawing 11 , but if it is between a liquid crystal panel 32 and the outgoing radiation side polarizing plate 35, it can be arranged in the location of arbitration. For example, it is also possible to arrange the optical compensation component 36 between the optical compensation component 33

and the optical compensation component 34, or to arrange it between a liquid crystal panel 32 and the optical compensation component 33. Moreover, although the optical compensation component 36 is in the condition of having estranged to other optical elements, in drawing 11 , you may be in other optical elements 34, for example, an optical compensation component, and the stuck condition.

[0064] Drawing 12 expresses typically the relation between the array condition of the liquid crystal molecule which constitutes the liquid crystal layer 44, and the array condition of the internal matter which constitutes the optical compensation components 33, 34, and 36 by the index ellipsoid. In addition, the array condition of the liquid crystal molecule shown in drawing 12 shows the thing in the condition of having impressed the electrical potential difference to the liquid crystal layer 44. With the gestalt of implementation of the above 1st, only the birefringence produced with the liquid crystal molecule which exists in the incidence side field of the light in the liquid crystal layer 44 and an outgoing radiation side field was canceled. With the gestalt of this operation, the birefringence further produced with the liquid crystal molecule which exists in the interstitial segment of the liquid crystal layer 44 by the optical compensation component 36 is canceled.

[0065] As shown in drawing 12 , 44g of liquid crystal molecules which exist in the

interstitial segment of the liquid crystal layer 44 is in the condition that the molecule major axis was arranged to the plane of incidence of light by the vertical or condition (it is a condition near parallel or it to an optical axis 10) near it, in the energization condition. Here, since it has the birefringence by which 44g of liquid crystal molecules is equivalent to the birefringence which forward 1 axial crystal has and a thing, then the optical axis of 44g of liquid crystal molecules become parallel to an optical axis 10, a birefringence is not produced to the light which carried out incidence to parallel to the optical axis 10. However, much light carries out incidence to the liquid crystal layer 44 also from a slanting include angle to an optical axis 10 actually. Thus, if light carries out incidence from a slanting include angle to an optical axis 10, to the optical axis of 44g of liquid crystal molecules, light will carry out incidence and a birefringence will arise from across also in 44g of liquid crystal molecules. It phase-kills and the optical compensation component 36 cancels the birefringence produced when slanting light carries out incidence to the optical axis of 44g of this liquid crystal molecule. Internal molecule 36a which constitutes the optical compensation component 36 has the birefringence equivalent to the birefringence which negative 1 axial crystal has, and it is arranged so that the optical axis may become parallel to the optical axis of 44g of liquid crystal molecules used as the object for compensation in an energization condition.

[0066] In addition, as matter which has the birefringence equivalent to the birefringence which negative 1 axial crystal which constitutes the optical compensation component 36 has, it is possible like the optical compensation components 33 and 34 to use the disc-like compound of a publication for JP,7-333434,A, JP,8-5837,A, etc. In addition, if the matter which constitutes the optical compensation component 36 has optically the property of negative 1 axial crystal which can be compensated for the liquid crystal of not only a thing given [above-mentioned] in an official report but the central field in the liquid crystal layer 44, it can also use other matter.

[0067] As explained above, according to the gestalt of this operation, a liquid crystal panel is received. To the outgoing radiation side of light In addition to the optical compensation components 33 and 34, the 3rd optical compensation component 36 constituted with the matter which has the birefringence equivalent to the birefringence which further negative 1 axial crystal has is formed. Since the birefringence produced with the liquid crystal molecule which exists in the interstitial segment of the liquid crystal layer 44 was canceled, it can cross throughout the thickness direction of the liquid crystal layer 44, and the birefringence produced with a liquid crystal molecule can be canceled. Thereby, the display of black level can be improved further and image display with more high contrast can be performed.

[0068] Generally, since light is mostly irradiated by the optical axis to a liquid crystal panel in the liquid crystal display of a direct viewing type at parallel, it is rare for a birefringence to arise in the liquid crystal molecule which exists in the interstitial segment of a liquid crystal layer. Moreover, since an angle of visibility does not arise in the condition of usually seeing the screen from the transverse plane at the liquid crystal display of a direct viewing type, it is rare to cause lowering of contrast. On the other hand, in a projection mold liquid crystal display, light usually carries out incidence from various include angles to a liquid crystal panel. Moreover, the light which carried out incidence from various include angles integrates also with the image on which it is eventually projected by the screen. This also shows that the effectiveness which the optical compensation component 36 in the gestalt of this operation exerts on a contrast improvement in a projection mold liquid crystal display is large.

[0069] In addition, this invention is not limited to the gestalt of each above-mentioned implementation, but various deformation implementation is possible for it. For example, this invention can be applied not only to the projection mold liquid crystal display of 3 plate type but to a veneer-type projection mold liquid crystal display. Moreover, this invention is applicable also to the projection mold liquid crystal display which used liquid crystal other than a nematic liquid crystal.

[0070]

[Effect of the Invention] As explained above, according to the projection mold liquid crystal display given in claim 1 thru/or any 1 term of 12 Since the optical phase contrast which prepares the 1st optical compensation component in the outgoing radiation side of light to a liquid crystal display component, and is produced with the liquid crystal molecule in the incidence side field of the light of a liquid crystal layer was compensated For example, when a liquid crystal display component is the configuration which equipped the incidence side of light with two or more micro lenses, it also sets. Without being influenced of a micro lens, the optical phase contrast produced with the liquid crystal molecule in the incidence side field of light can be compensated, the display of black level is improved, and the effectiveness that high image display of contrast can be performed compared with the former is done so.

[0071] According to the projection mold liquid crystal display according to claim 8, it sets to a projection mold liquid crystal display according to claim 1 especially. Since the 3rd optical compensation component which compensates the optical phase contrast produced with the liquid crystal molecule which exists in the field except the incidence side field of light and an outgoing radiation side field among liquid crystal layers was further prepared in the outgoing radiation side of light to the liquid crystal display component For example, where it has the birefringence

by which each liquid crystal molecule in a liquid crystal layer is equivalent to the birefringence which forward 1 axial crystal has and an electrical potential difference is impressed The molecule major axis receives the plane of incidence of light as it goes to a core from the incidence side field of light. From the condition near parallel or it When being arranged so that it may be in the vertical or condition near it to the plane of incidence of light, and an array condition may change, the optical axis of the 3rd optical compensation component in arranging so that it may become parallel to the molecule major axis of the liquid crystal molecule used as the object for compensation The effectiveness that not only the optical phase contrast produced with the liquid crystal molecule in the incidence side field of light but the optical phase contrast produced with the liquid crystal molecule which exists in the field except the incidence side field of light and an outgoing radiation side field can be compensated is done so. Image display with contrast high thereby more can be performed.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing the whole projection mold liquid

crystal display configuration concerning the gestalt of operation of the 1st of this invention.

[Drawing 2] It is the sectional view showing the outline configuration of the liquid crystal panel section in the projection mold liquid crystal display shown in drawing 1 .

[Drawing 3] It is the sectional view showing the detailed configuration of the liquid crystal panel shown in drawing 2 .

[Drawing 4] It is the explanatory view which expresses the array condition of the liquid crystal molecule when not impressing an electrical potential difference with the liquid crystal layer shown in drawing 3 .

[Drawing 5] It is an explanatory view showing the array condition of the liquid crystal molecule when impressing an electrical potential difference to the liquid crystal layer shown in drawing 3 .

[Drawing 6] It is the explanatory view showing various kinds of shaft orientations between each optical element in the liquid crystal panel section shown in drawing 2 .

[Drawing 7] It is the explanatory view showing the relation between the array of the liquid crystal molecule in the liquid crystal panel shown in drawing 2 , and the molecular arrangement in an optical compensation component.

[Drawing 8] It is the explanatory view showing the example of a comparison over

the array relation between the liquid crystal molecule shown in drawing 5 , and the molecule in an optical compensation component.

[Drawing 9] It is the explanatory view showing the optical property of forward 1 axial crystal.

[Drawing 10] It is the explanatory view showing the optical property of negative 1 axial crystal.

[Drawing 11] It is the sectional view showing the outline configuration of the liquid crystal panel section in the projection mold liquid crystal display concerning the gestalt of operation of the 2nd of this invention.

[Drawing 12] It is the explanatory view showing the relation between the array of the liquid crystal molecule in the liquid crystal panel in the gestalt of operation of the 2nd of this invention, and the molecular arrangement in an optical compensation component.

[Drawing 13] It is a sectional view showing the example of a configuration of the liquid crystal panel periphery in a common projection mold liquid crystal display.

[Drawing 14] It is a sectional view for explaining the optical trouble produced in the conventional projection mold liquid crystal display.

[Drawing 15] It is a sectional view for explaining the case where the optical compensation component used in the liquid crystal display of the conventional direct viewing type is applied to a projection mold liquid crystal display.

[Description of Notations]

10 [-- A dichroic prism, 26 / -- A projector lens, 27 / -- A screen, 31 / -- An incidence side polarizing plate, 32 / -- A liquid crystal panel, 33 34, 36 / -- An optical compensation component, 35 / -- An outgoing radiation side polarizing plate, 42 / -- A micro lens, 44 / -- A liquid crystal layer, 45 / -- 48 The pixel polar zone, 49 / -- Orientation film.] -- An optical axis, 11 -- The light source, 24 (24R, 24G, 24B) -- The liquid crystal panel section, 25